# Menlo Park Notebook #28 [N-79-02-15.1]

This notebook covers the period February-November 1879. Most of the entries are by Edison and Francis Upton. There are also entries by Charles Batchelor and Francis Jehl. All of the entries relate to electric light and power experiments, except for one drawing by Batchelor of a telephone circuit. The electric light material includes notes, calculations, and tests of lamps; notes, drawings, and calculations relating to generators; and notes and calculations about electric power distribution. The book contains 278 numbered pages.

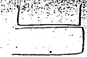
Blank pages not filmed: 234-277.

Missing page numbers: 51-52, 89-90, 107-108, 279-280.

No28

130 lbs of Cu wire
30 cts
26cts a lb.

850 lbs wrought
6 cts.
5 1/2 wrought
4 3/4 square



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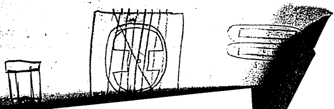

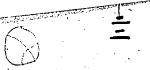

No28

130 lbs of Cu wire
30 cts

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BOARD OF PATENT CONTROL,

120 BROADWAY, NEW YORK.

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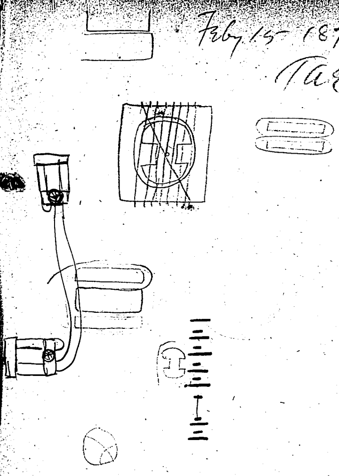
May, 1890.



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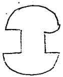

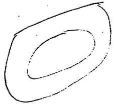

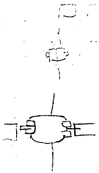

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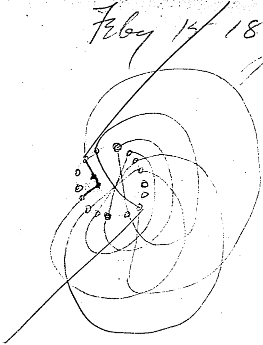

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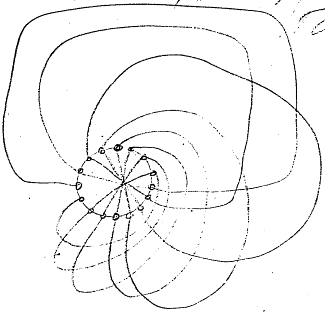

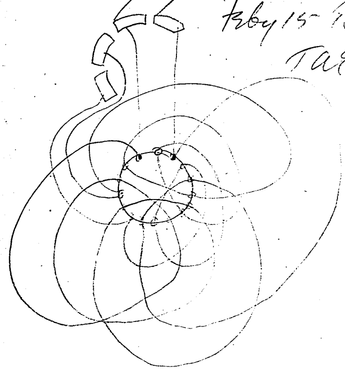

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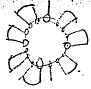

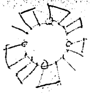

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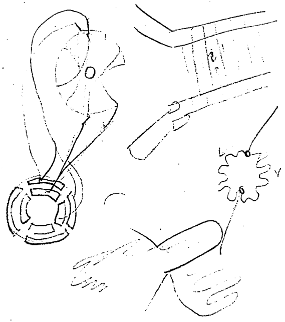

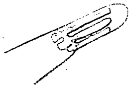

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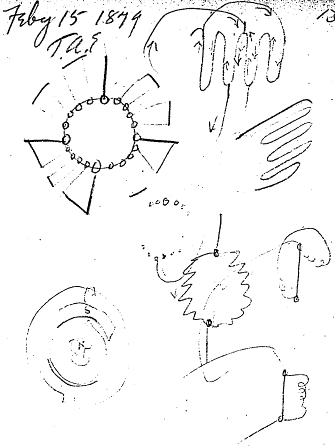

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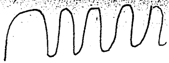

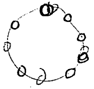

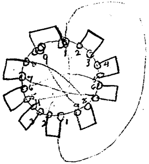
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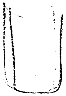

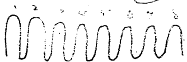

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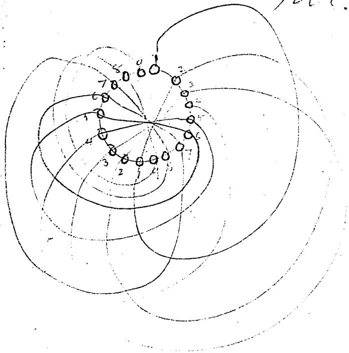
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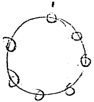

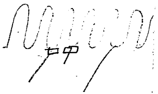

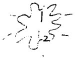

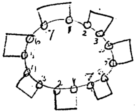

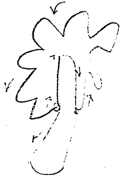

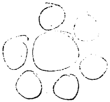

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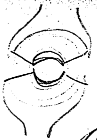

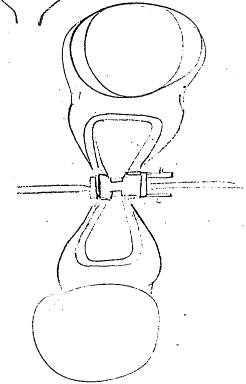

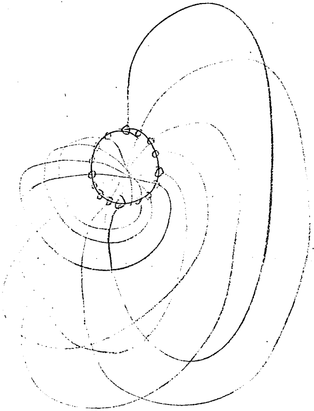

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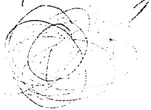

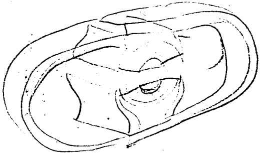

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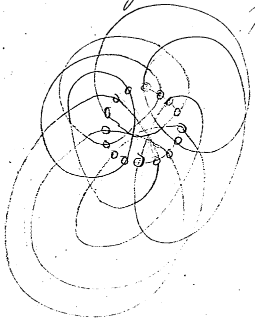

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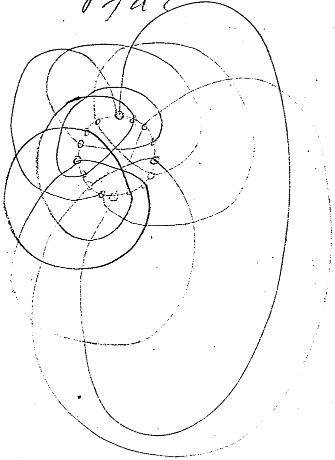

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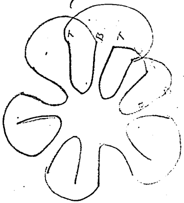

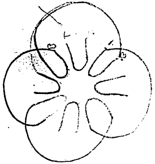

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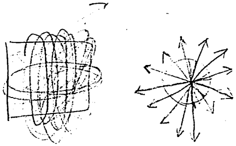

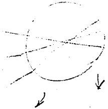

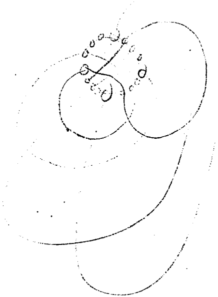

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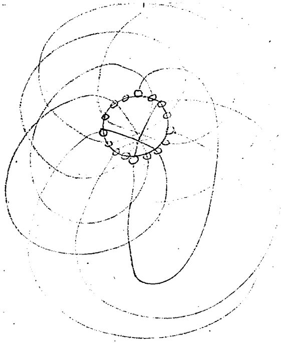

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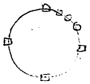

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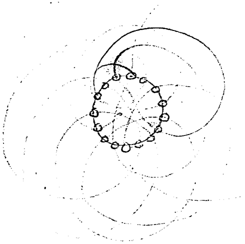

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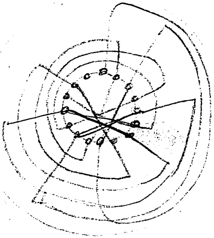

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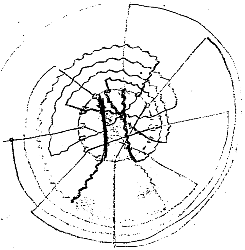

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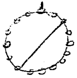
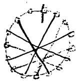
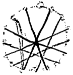
Dynamo Machine

T. A. E.

Feb. 16 1879







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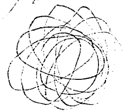

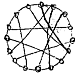

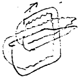

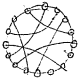

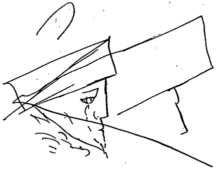

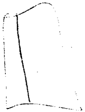

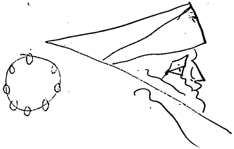

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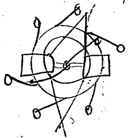
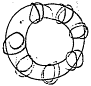
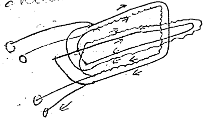
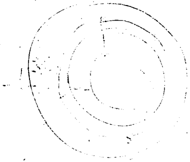
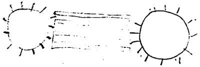


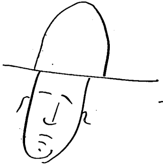


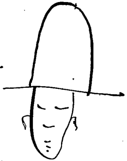
Machine without Commutator

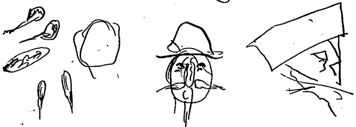


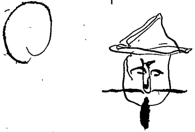












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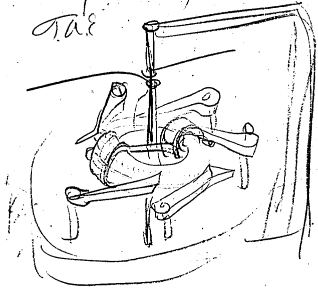

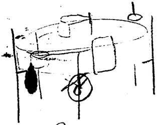

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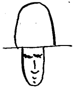
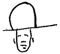
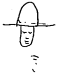
Machine without Commutator







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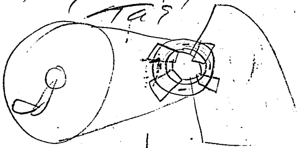

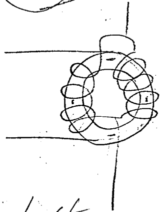

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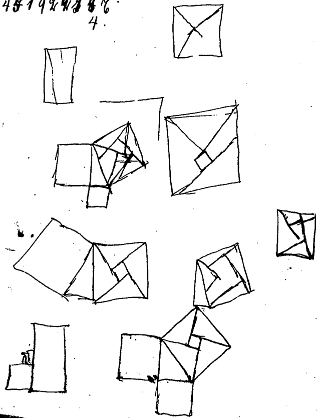

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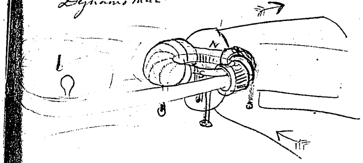
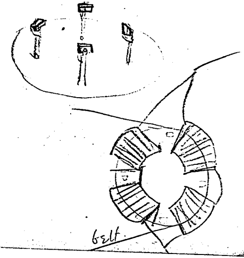
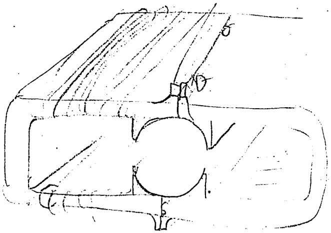
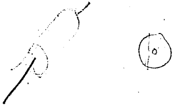
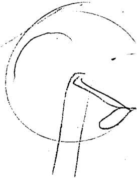


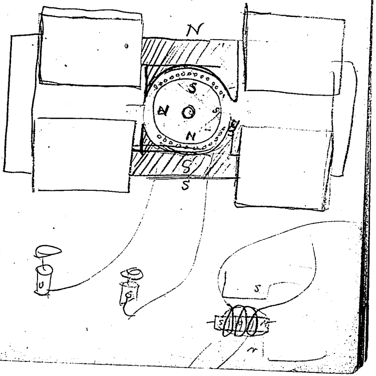






Feb. 16, 1878

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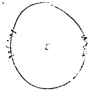

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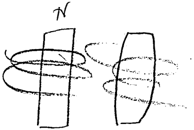

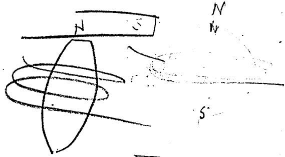

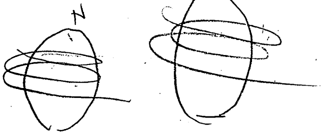

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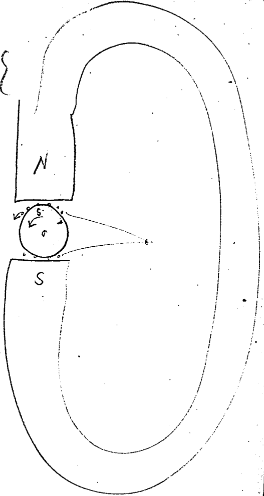

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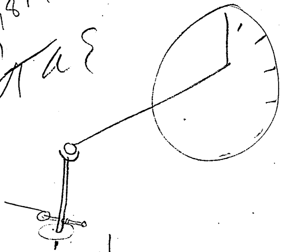

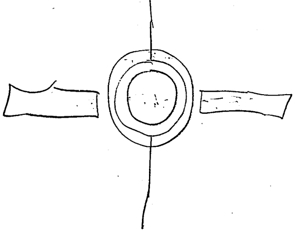

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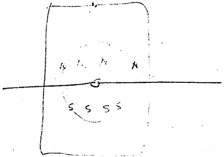

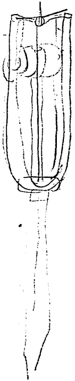

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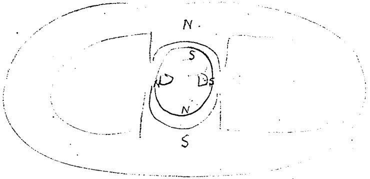

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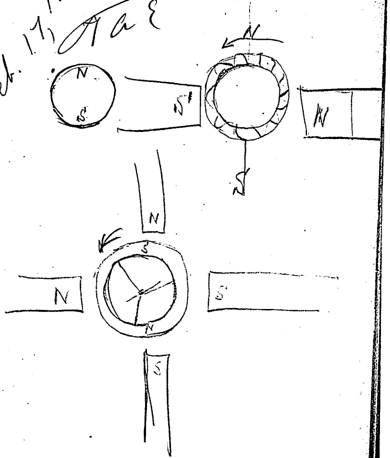
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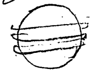

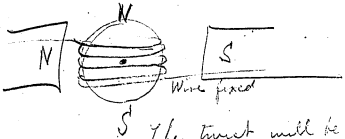
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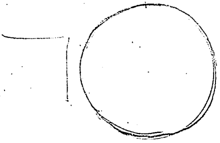
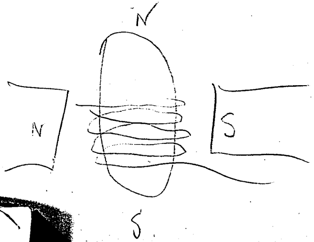
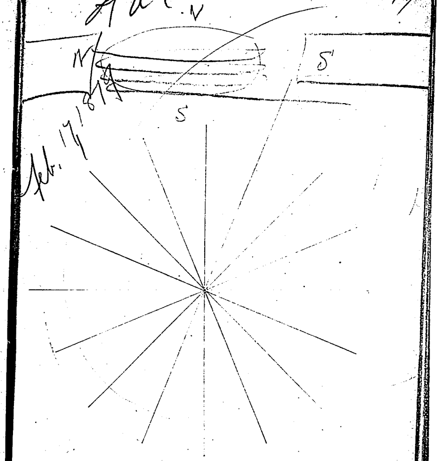
Wire fixed

The twist will be on the wire and not on the iron core







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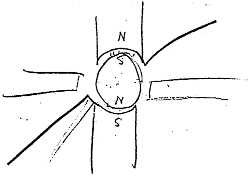

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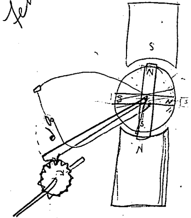

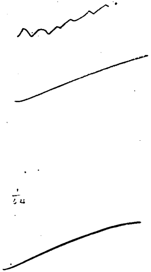

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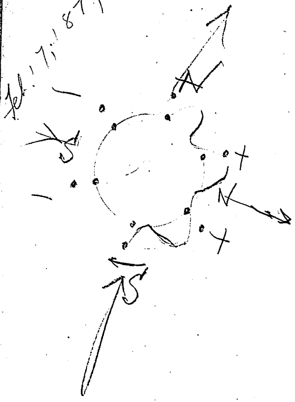

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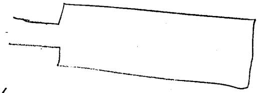

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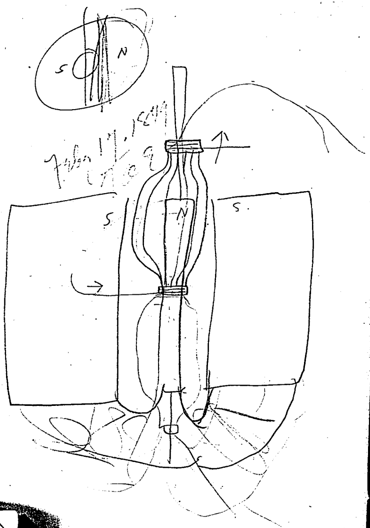

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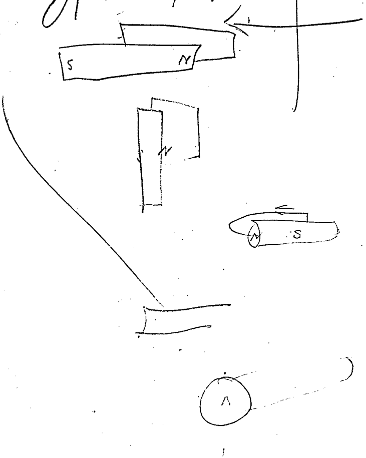

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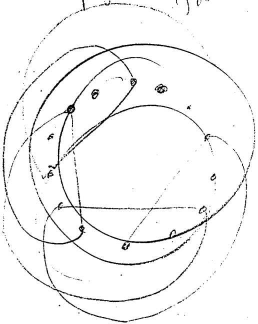

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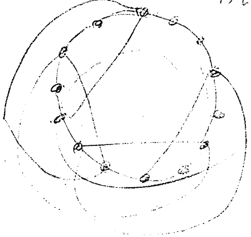

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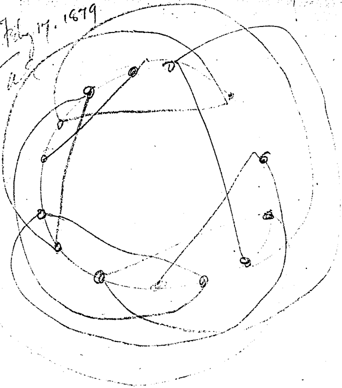

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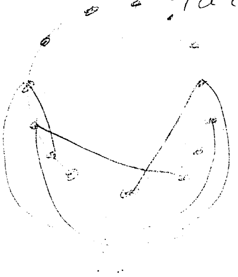

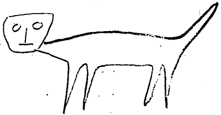

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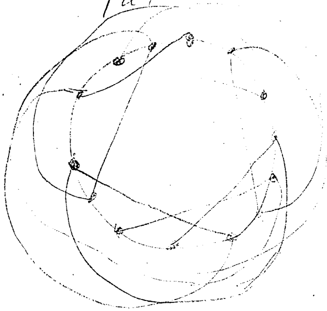

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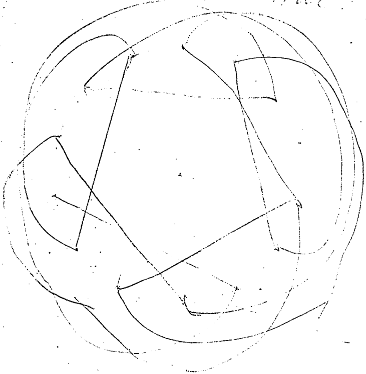

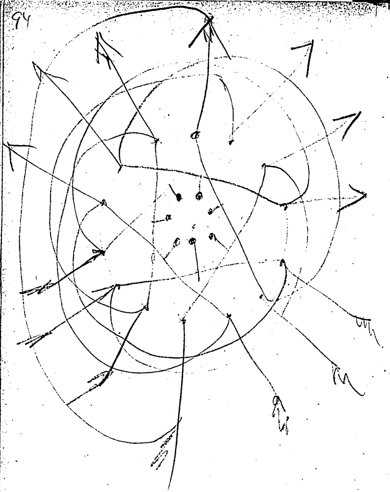

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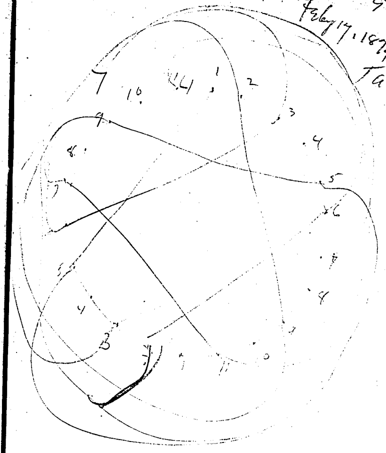
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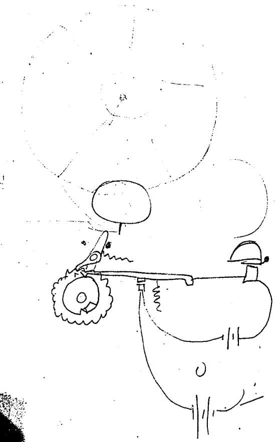

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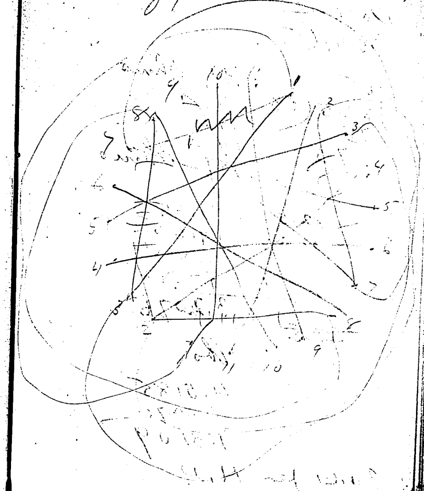
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30 am

75 Volts

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75

75

34 ohms

5.5

170

170

187 ohms

| | |
|---|---|
| 82.5 | 1.9165 |
| 82.5 | 1.9165 |
| 44.3 | 1.6464 |
| Comp 187 | 7.7282 |
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~~255.5~~

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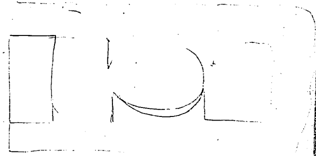

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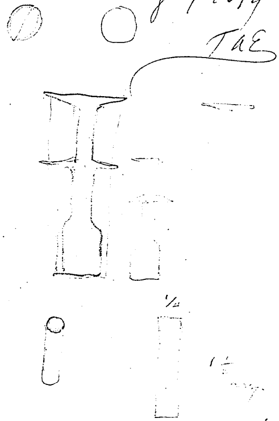

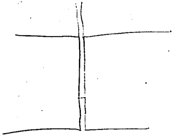

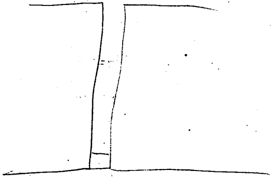

February 28 1879

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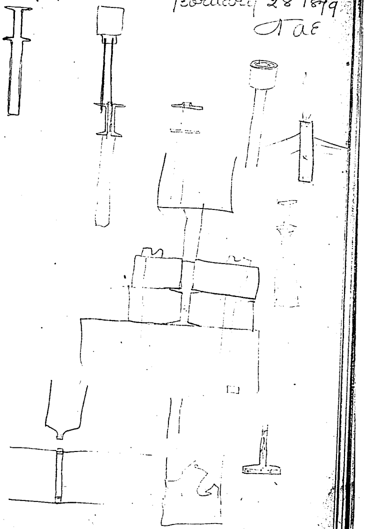
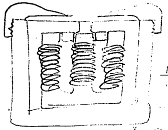


Railway Round Round

Railway



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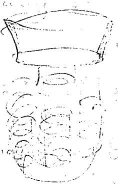

Railway

Portland

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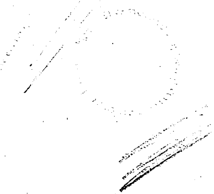

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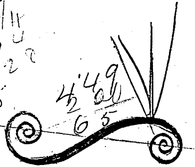

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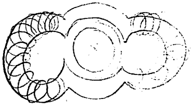
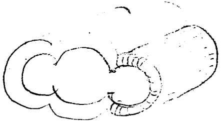
No 1

X cylinder stands alone
wire ~~thrown~~ through lines
force -





Over

[illegible] this is so
account [illegible] to try ~~[illegible]~~
~~field~~ [illegible]
winds it two ways = 3rd rotate

116

Experiments to be tried.

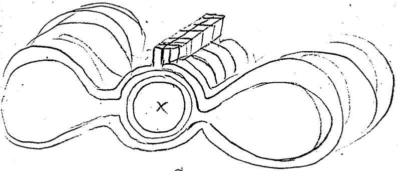
Rotate wire wound in odd no.
" " " in Even with end. opp.

Open field magnet put iron on sides
put in Siemens armature hold
wire still & rotate armature
wind magnet our way. test
against Siemens -

hold best magnet (1e) Siemens armature
or our slice rotate wire wound
both Even & odd.

---

No 2 117

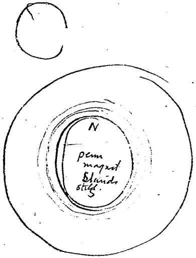


Permanent magnet.

X cylinder of iron [illegible]
wire mass

~~Magnet Experiments~~

No 3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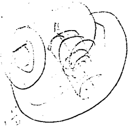

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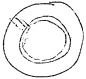

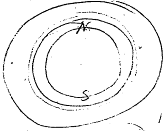

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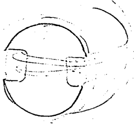
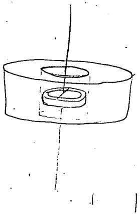
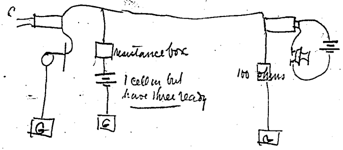





C
resistance box
1 cell in but have three ready
100 ohms
G
G
G

36 Ohms 1/6 current

No. 16 wire 259 turns per Ohm

36 2.4131
1.5563
3.9694
9320 turns .7782
1/6 current 3.1912
1550

---

No. 10 wire
1090 feet per Ohm
Strength = 1090 94 lbs
Strength = 1550

---

No 16 wire 5.23 .7183
36 1.5563
2.2746

187 lbs of wire 1.5 more effective on six Ohms total

---

Francis R. Upton

Fran Francis R. Upton

Francis R. Upton

Francis R. Upton

Francis R. Upton

369
50

$ 18,000

Francis R. Upton

$100.

$100.

$ 36,000 a year

$ 18000

$ 18.000

$

365.00

360

1/10 1/10
1/10 1/10

$365.00 $100

$36.500

$36.500

$36.500
$36.500

~~36.500~~

What is the 1/10 rose?

$365000

1/10

1/10

1/10

$10

1/10 1/10 $2 600 000 1/10

$6000 a year

$2.00

$2.00

$2.00 2.00 2.00 2.00

$2.00

2.00

~~Hope~~ $300

~~Cash~~ 100 ~~Board~~

$2.00

$2.00

~~How do you go it Upton~~

36.500

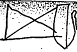
~~$36,000000~~

~~$36,000000~~

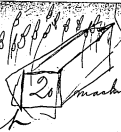
1/10 1/10

1/10

1/10 1/10 1/10



β β β β β β β β β β β β β β β β β



80 H.P. engine 20 machines requiring 4 H.P each

Two machines ~~laying~~ driving the fields of the others

magnet magnets magnets magnets magnets magnets magnets magnets

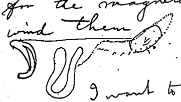
9 machines ~~to each~~

magnets magnets

9 machines to each

What is the best resistance for the magnets. and how wind them

Machines Machines



I want to know the strength of current from magnets current from current from from from from

Jl

Required the strength of the magnetising current and the ~~strength~~ of the current from the machine.

The magnetising current could be measured by the dynamometer ~~the other by~~ the Electrometer. Electrometer

~~Electrometer~~

2 lamps in series
1 unit of surface each
1 unit of energy from each

1. lamp

a lamps in series
unit of surface each
" " energy from "

1 lamp in multiple utilizing the same E. M. F as a lamps in series what will be the resistance of a lamp?

$\frac{1}{a}$ energy given off on unit of surface

---

$$\frac{\mathcal{E}^2}{R_x} = \frac{1}{a} \qquad \mathcal{E} = 1$$

$$\frac{1}{R_x} = \frac{1}{a} \qquad C = \frac{\mathcal{E}}{R}$$

$$C^2 R = W$$

$$\frac{\mathcal{E}^2}{R} = W$$

$$\frac{1}{R} = a$$

$$\frac{1}{R_x} = \frac{1}{a}$$

$$\frac{a^2}{R_x} = \frac{1}{R}$$

$$R_x = \cancel{a^3 R}\ a^2 R$$

---

$\mathcal{E}_2 = \mathcal{E}_1 \frac{r_2}{r_1}$ $\mathcal{E}_2 r_1 = \mathcal{E}_1 r^2$

$\mathcal{E}_2 = \mathcal{E}_1 \frac{r_2 + b}{r_1 + a}$

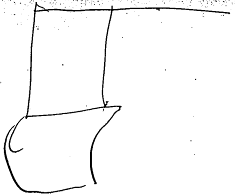
$\mathcal{E}_2 a = \mathcal{E}_1 h$

$\mathcal{E}_2 = \mathcal{E}_1 \frac{h}{a}$

---

685
40
274.00
127.40
13.70

6666



$\mathcal{E} = 20$ 16. ohm

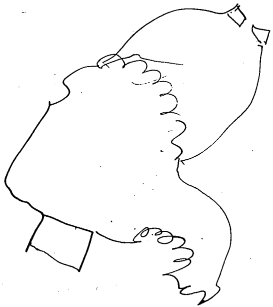
$\frac{400}{16} = 25 =$ Work

$C = \frac{\mathcal{E}}{R}$ $\frac{100}{16} = \frac{25}{4} = 6\ 1/4$

$C^2 R$

$\frac{20}{16} = \frac{5}{4} =$ Current

$\frac{25}{16} \times 16 = 25 =$ Work



485000 000

485,000000

2 485000000

8 83cts. cts. cts cts. cts.

83cts. cts. cts. cts. cts

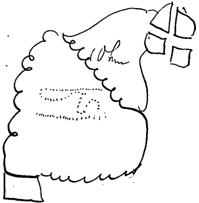
8 3 83 83 83 cts cts

83cts. 83 cts. 83cts.

83cts. 83cts 83 cts

83cts

~~83~~



309.

5  .3,
4
3
2

=

2350
44
9400
9400
103.40

1
1  2
16  32
229
1
16  5  100.
$\frac{1}{100}$
6.  9/16
9.
32. 36 ahm 9/6.

100.  $\frac{54}{16}$

20 – at $\frac{1}{4}$.

5)125
25.
25.
5.
44.

1
1 2
289 P6 32
1
16 5 100.
1/100
1.6. 9/16
6.
32 25 36 ahm 9/6.

100. 54/16

20 - at 1/4.

5)125
25.
25.
5.
44.

359.

5
4
3 .3.
2

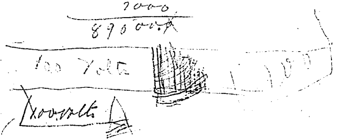
=

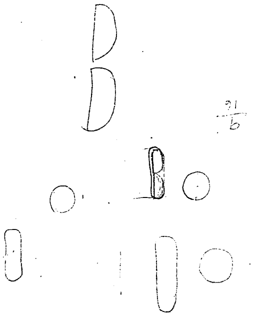
2350
44
9400
9400
103.400

100 Volts on 5 Ohms
external

20
2000

44.5
2000
890000


100 Volts
100 volts


91
6

I want to know the E. M. F. requisite — in a 100 Ohm lamp when 4, 5, 6, 7, 8, 9, 10, 11, are obtained per H.P.

44,5

$$44{,}5\,\frac{E^2}{R} = \frac{H.P}{4}$$

$R = 100$

$$E^2 = 100\,\frac{H.P.\,\cancel{\otimes}}{4 \cancel{\times} 44{,}5}$$

$$E = \sqrt{100\,\frac{H.P}{4 \times 44{,}5}}$$

100
33000
comps 178.

4,45
4
~~17,8,0~~
178

6,5185

2.
4.5185
7.7496
4.2681
2.1340

136 Volts 4 per H.P

$$\sqrt{100\,\frac{H.P}{3 \times 44.5}}$$

44.5
5
222.5

222.5

6.5185
2.3474
4.1711
2.0855

121 Volts

6 per H. P

44.5

6.5185
1.6484
4.8701
.6 .7782
(4.0919
111 Volts 2.0454

7 per H. P

4.8701
.8451
(40250
103 Volts 2.0125

8 per H. P.

4.8701
.9031
96.3 Volts 2)3.9670
1.9835

9 per H. P

4.8701
9542
(3.9159
(1.9579
90.8 Volts

10 per H. P
4.8701
1
2)3.8701
1.9350
86.1 Volts

11 per H. P
4.8701
1.0414
3.8287
83 Volts ~~1.8693~~
1.9143

~~75 1,8751~~
~~75 1,8754~~
~~comp ,00 8. -10~~
~~44.5 1.6484~~

~~3.1986~~

~~1580~~

~~4.5185~~
~~3 1986~~

~~1.3199~~

~~20.8 per H.P.~~

---

1 per H.P

4,8701
2,4350

266 Volts

2 per H.P.

4,8701
,3010
4,5691
2,2845

192 Volts

---

3 per H.P 4,8701
,4771
4,3930
2,1965

157 Volts

---

4 per H. P 4,8701
,6021
2 4.2680
2.1340

136

E.M.F required to run a 100 Ohm lamp.

| If there are obtained for each horse power this number of lamps | |
|---|---|
| .1 | |

4.8701
1.0792
~~3.7309~~
~~1.8654~~
3.7909
1,8954

~~87~~
4.8701
1.1139
3.7562
1.8781

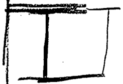
4.8701
1.1461
3.7240
1.8620.

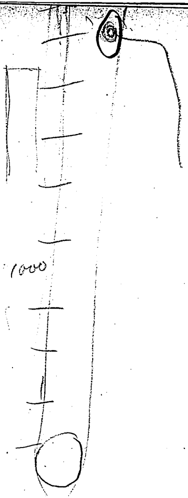
4.8701
1.1761
3.6940
1.8470

Work Energy

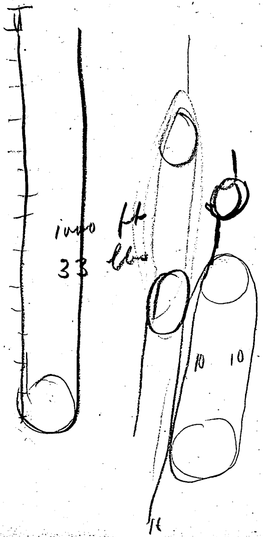
Energy Work

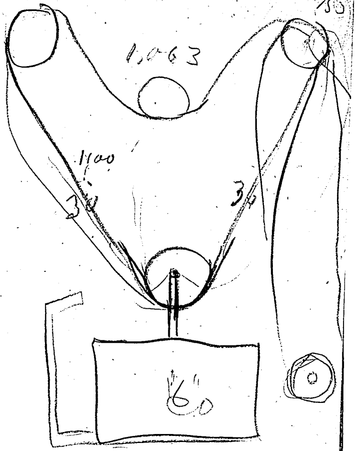
||||

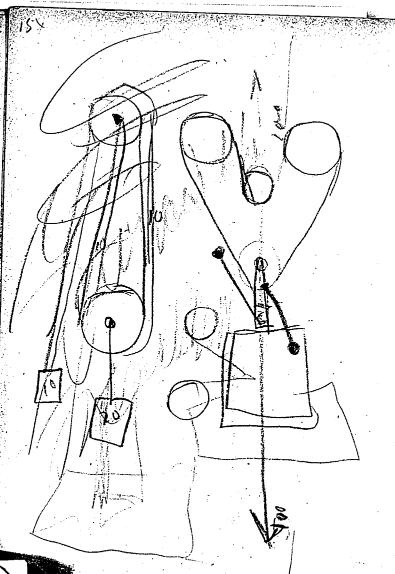




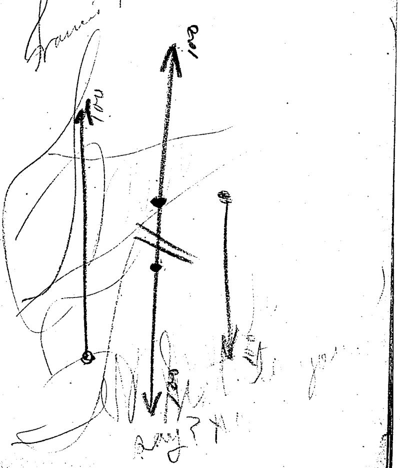
1000

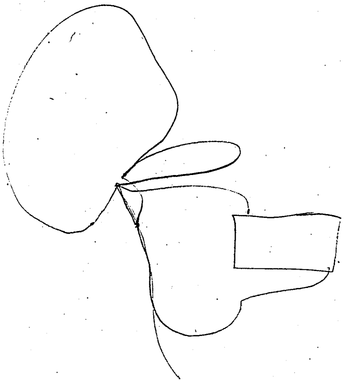

1000 ft
33 lbs
10
10
ft

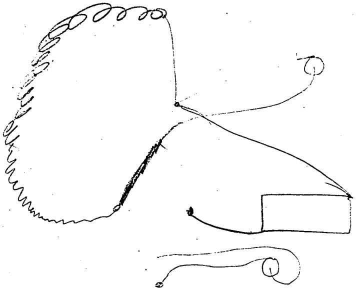

1,063
1100
30
3
6'0

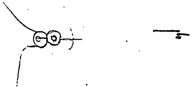

10
10
10
20
100

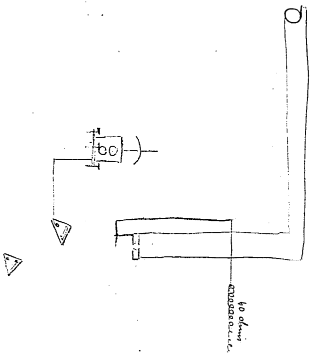
Francis R

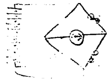


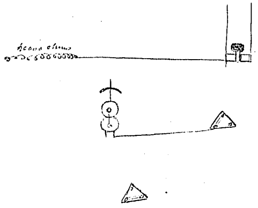







60 ohms




Acorn chain

960

Experiments on Standard Dynamo Machine. July 7 1879

T. A. Edison

10 Experiments to determine decreasing of weight with no belt on Dynamo
(1st) starting or fiducial weight,

---

Speed Shaft 185
took speed 5 times - same each time

938½ @ 9½ =     938½ - 920

944½ - 910 - Mean of whole.

| | | |
|---|---|---|
| 946½ | 910 | 927.37 |
| 943½ | 912 | Initial weight |
| 943 | 913 | |
| 940½ | 911 | |
| 940 | 915 | |
| 943½ | 913 | |
| 938½ | 918 | |

we now take 10 weighings with belt on Dynamo, circuits open speed of Dynamo, 1st time 524.- 2nd time, 524 —

---

| | |
|---|---|
| 936 ½ | – 904 |
| 935 | 909 |
| 935 | 910 |
| 934 | 906 ½ |
| 935 – | 906 ½ |
| 934 ½ | 908 |
| 934 | 908 |
| 934 | 908 |
| 934 | 908 |
| 935 | 908 |

Mean deflection of balance,

921.2

Lessening of weight

6.17

Ceiling speed of shaft 184. the speed of belt is 1143 feet.

This would give 3757. foot lbs absorbed by machine, or $8\frac{9}{10}$, machines per h power –

We now put battery on field magnet, Resistance of field mag $\frac{90}{100}$ of ohm, Volts passing $8\frac{2}{10}$ volts, Dif Tan gal $60\frac{1}{2}$

speed shaft 134 – [illegible] 56
" Dynamo 534 -

903 – $934\frac{1}{2}$ Mean defl [illegible]
$904\frac{1}{2}$ 933
903 $930\frac{1}{2}$ 915.85
903 $928\frac{1}{2}$
902 $928\frac{1}{2}$ Dif 11.52
903 $926\frac{1}{2}$
903 928 or 7010 foot lbs
902 927, showing that [illegible]
908 $925\frac{1}{2}$ of field [illegible] machine
901 925. of 3253.

168

1140

22

22

5700

63 105

32 5980

27

575

520

---

169

We now take Current from

The Machine –

Speed Main shaft 186.

47½ deg on Tangent G.

| | |
|---|---|
| 1 | |
| 815 | 843½ |
| 820 | 845½ |
| 820 | 845 |
| 819 | 843 |
| 818 | 847½ |
| 818 | 847½ |
| 823½ | 850 |
| 822 | 850 |
| 821½ | 850 |
| 820 | 847 |

Another ~~test~~ using more power, by having bobbin on smaller external resistance;

Gal $44\frac{1}{2}$

$854\frac{1}{2}$ 820

848 – 820

Battery giving out.

We make R smaller outside & test again =

$837\frac{1}{2}$ + 804 = 2)1641.5 = 820.75

835 + 808 = 2)1647 823.5

832 + 808 = 2)$1640\frac{1}{2}$ 820.25

838 + 806 = 2)1644 822

838 + 808 = 2)1646 823

5)4109.5

821.9

5000 ft. lbs ; on 2 layers
Cost 10 hours a day a 1ct.
a H.P.

30000 a day

33)500(1.51
33
170
165
50
3

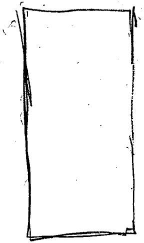
1.51 H. P. a day

1.51 Cts a day

365
1.51
365
1825
365
551.15

$ 5.51

Cost $23 to put in twice
as many layers



4. F.

½ Diameter

¼ times the convolutions

16 times the resistance

The same E.M.F

1/16 the current

1/4 as strong

1/4 the current

the same strength

1/16 X 16 = 1 Cost

130 lbs of Copper
30
$39.00
42.50
$81.50 — $42.50 (850 / 5)

$8.15 at 10% and

10 6/$36.50 $6.08 10 $36.50

$1.00 2 cts. per H.P.

20 cts an hour

~~H~~ H.P

2½ 25 lights

lights lights ~~lights~~

M/5 1/5 ct cost H.P.

Unit   lamps per hour
10 per H.P.

3 hours each day

2 cts cost power
.2 ~~cts~~ per lamps per hour

$100 per H.P. engines boilers
$10 per lamps per H.P.
$3.33 dynamo
$7.50 Conductor   365
3
36 $20.83   1095
2.83
1000 hours a year
.28 ct. interest
.20
.48 per hour

[illegible]   1.00 per M
1.00 per M ton

Land
$200 for dynamo Machine
80 lamps
333

Two cells   Two cells

Two cells   Two cells
Two cells   Two cells
Two cells   Two cells

Two cells   Two cells
150 Ohm lamps
14 per H.P. theoretical to make the lamp a ~~thoroughly~~ brilliant success. $20,000.00 The lamp must be permanent and last years. This E.B. gas.

Nov 3 1879 A.1

Ex. Testing Carbon Lamp.

Ex cord Thread .02

Resistance of lamp when cold

86.—.1 = 85.9 lamp when cold

I made 5 cut Daniell & 6 chromic cell = 35. about 17 volts one volt = 2

53 : 78 :: 36.6 : X

36.6 1.563481
78 1.892095
3.455576
1.724276
1.731300

Cherry Red 53

= R. ~~53.86~~

39 1.591065
2
3.182130
1.646404
4.828534
R of L 1.733300
3.097234 = ft lbs 1251.

ft lbs 1251.

36.9 : X :: 78 : 107

78 = 1.892095

Bright Red

ft lbs 2467

107 = 2.029384

R.=50.61

ft lbs ~~1331~~

~~4.828534~~
~~1.704315~~
~~3.124219~~ = 1331. ft lbs

2467 ft lbs

3.596410
1.892095
1.704315

Bright white

37.1 : X :: 82 : 110

37.1 = 1.569374
110 2.041393
3.610767
82 1.913814
1.696953 = R.

R. 49.76

~~4.828534~~
~~1.696953~~

~~1.740363~~
~~2~~
~~3.480726~~
~~1.696953~~
~~1.783773~~

3.480726
1.646404
5.127130
1.696953
3.430177 ft lbs

2702. ft lbs

Brilliant white

30.7 : X :: 78 : 121

R. 47.62

3,348. ft lbs

30.7 1.487138
121 2.082785
3.569923
78. 1.892095
1.677828 = R

1.778151
2
3.556302
1.646404
5.202706
1.677828
3.524878 = ft lbs

~~To~~ 80 ohms when measured
cold now

1 litre of air weighs
1.293 Grammes

.45359 Kilo

453.59 Grammes

453.5

1.293

2.65658
0.11160
2.54498

350.7 Litres
1.135

2.54498
.05500
2.59998

398 Quarts
99.5 Gallons in
a pound of air about

100
100

10000
44.3

25)443,000(177.000
25
193
175
180

33)177(5.4
165
120

.27

33000
8250
5500
13750
8280
21900

1st Lamp 2310
2 Lamp each. 2277
4 Lamp each. 2212

2212
186
2286

2212

2212
$124\frac{1}{2}$
2088.

$26\frac{1}{2}$ 83.

$26\frac{1}{2}$ ) 2212 ( 83
212
92
$79\frac{1}{2}$
212 $13\frac{1}{2}$.

$83\frac{1}{2}$

$1\frac{1}{2}$

2380
11
2380
2380
180

$11\frac{1}{2}$ ) 234476 ( 2380
23
0044
$34\frac{1}{2}$
$10\ 7\frac{1}{2}$

$101\frac{1}{2}$

Portland

73
73
219
511
5329
44
21316

2
4
8 12

4 ) 8848
2212

21316
$101\frac{1}{2}$ ) 234476 ( 2310
Morning
314
Morning $304\frac{1}{2}$
$107\frac{1}{2}$
$101\frac{1}{2}$
6

Glory
Glory Good

$304\frac{1}{2}$

$26\frac{1}{2}$ ) 234476 ( 8848
212
224
212
127
106
216
212

Good

Good 2310.

Goodlove

$51\frac{1}{2}$

[illegible]

$51\frac{1}{2}$ ) 234476 ( 4554
206
284
$257\frac{1}{2}$
$27\frac{1}{2}$
$25\frac{1}{2}$
206
206

4554
2277

| | | | |
|---|---|---|---|
| 1 lamp | | 2300 | 71.9 |
| 2 | " | 2220 | 70.9 |
| 3 | " | 2160 | 69.8 |
| 4 | " | 2100 | 68.9 |
| 5 | " | 2040 | 67.9 |
| 6 | " | 1980 | 67. |
| 7 | " | 1920 | 66. |
| 8 | " | 1860 | |
| 9 | | 1800 | |
| 10 | | 1780. foot lbs | |

10 lamps 1 ohm Candle 1/2 ohm machine

above will be the drop in foot lbs on the lamps as they are put on

Then if 2300 foot lbs gives 16 Candles on one ~~lamp~~ then 1780 will give

9 7/10 ~~10~~ Candles

no Regulation,

Table with regulation at Station,

| | | | |
|---|---|---|---|
| 1 lamp | | 2305 | 72.4 |
| 2 | " | 2268 | 71.5 |
| 3 | " | 2220 | 70.8 |
| 4 | | 2182 | 70.2 |
| 5 | " | 2141 | 69.5 |
| 6 | " | 2100 | 68.8 |
| ~~8~~ | " | 2023 | 67.6 |
| 10 | | 1951 | 66.3 |

Keeping ~~record~~ EMF at machine Constant. above ~~table~~ gives distribution of Foot lbs — 2305 ft lbs gives 16 Candles; ~~then~~ 1951 foot lbs will give, 11 3/10 candles

Regulation.

1

100 2.
101.5 2.00647

$\bar{1}$.99353
71.92 1.85685

$\bar{1}$.98706
~~[illegible]~~
3203 3.50557

$\bar{1}$.97412
15.07 1.17824

100 2
101 2.00432
99 .99568
72.28 1.85900

$\bar{1}$.99136
3235 3.50987

$\bar{1}$.98272
15.38 1.18664

2

50 1.69897
51.5 1.71181

$\bar{1}$.98716
70.87 1.85048

$\bar{1}$.97432
3111 3.49283

$\bar{1}$.94864
14.27 1.15276

50. 1.69897
51. 1.70757
98. $\bar{1}$.99140
1.85472
71.57 1.85472

$\bar{1}$.98280
3.50131
3173 3.50131

$\bar{1}$.96560
1.16972
14.78 1.16972

3

33.33 1.52284
34.83 1.54195
.98089
~~70.02~~
6986 1.84421

$\bar{1}$.96178
3022 3.48029

$\bar{1}$.92356
13.42 1.12768

33.33 1.522848 9
34.33 1.53567
97.1 $\bar{1}$.98717
70.88 1.85049

$\bar{1}$.97434
~~3116~~
3111 3.49285

$\bar{1}$.94868
14.22 1.13280

4

25. 1.39794
26.5 1.42325
$\bar{1}$.97469
68.87 1.83801

$\bar{1}$.94938
2937 3.46789

$\bar{1}$.89876
12.67 1.10288

25. 1.39794
26. 1.41497
961 $\bar{1}$.98297
70.19 1.84629

$\bar{1}$.96594
3051 3.48445

$\bar{1}$.93188
13.70 1.13600

5

5) 20 1.30103
21.5 1.33244

$\bar{1}$.96859
~~69.54~~ ~~1.82231~~
~~67.95~~ 1,83191
6791

~~$\bar{1}$.93778~~
~~28.60~~ ~~3.45627~~
$\bar{1}$.93718
2856 3.45569
~~$\bar{1}$.87556~~
~~12.01~~ ~~1.07968~~
11.98 $\bar{1}$.87436
1.07848

20 1.30103
21 1.32222

952 $\bar{1}$.97871
69.51 1,84203

$\bar{1}$.95742
29.92 3.47593

$\bar{1}$.91484
13.15 1.11896

6) 16.67 1,22194
18.17 1.25935

$\bar{1}$.96259
66.98 1.82591

$\bar{1}$.92518
27.78 3.44369

$\bar{1}$.85636
11.37 1.05448

16.67 1.22194
17.67 1.24722 ~~1.23045~~

~~9149~~
94.3 $\bar{1}$.97470
68.87 1.83802

$\bar{1}$.94940
29.37 3.46791

$\bar{1}$.89880
12.67 1.10292

7) 14.28 1.15473
15.78 1.19811

$\bar{1}$.95662
66.06 1.81994

$\bar{1}$.91324
2702 3.43175

$\bar{1}$.82648
1070 1.03066

14.28 1.15473
15.28 1.18412

93.4 $\bar{1}$.97061
~~69.17~~ 1.83393
6822

$\bar{1}$.94122
2882 3.45973

$\bar{1}$.88244
12.21 1.08656

8) 12.5 1.09691
14 1.14613

$\bar{1}$.95078
~~1.80410~~
65.18 1.81410

~~$\bar{1}$.88156~~
~~3.40007~~
$\bar{1}$.90156
2631 3.42007
~~$\bar{1}$.76312~~
~~0.96724~~
$\bar{1}$.80312
101.7 1.00724

12.5 1.09691
13.5 1.13033

92.6 $\bar{1}$.96658
67.60 1.82990

$\bar{1}$.93316
2829 3.45167

$\bar{1}$.86632
11.77 1.07044

9

~~10.111~~

11.111 1.04575 11.111 1.04575

12.611 1.10075 12.111 1.08317

$\bar{1}.94500$ 91.7 $\bar{1}.96258$

64.33 1.80832 66.97 1.82598

$\bar{1}.89006$ $\bar{1}.92516$

2562 3.40851 2778 3.44367

$\bar{1}.78000$ $\bar{1}.85032$

.9641 0.98412 11.33 1.05444

10

10 1.00000 10. 1

11.5 1.06070 11 1.04139

$\bar{1}.93930$ 90.9 $\bar{1}.95869$

63.48 1.80262 1.82201 66.38

$\bar{1}.87860$ $\bar{1}.91738$

2495 3.39711 3.43589 2728

$\bar{1}.75720$ $\bar{1}.83476$

9.148 0.96132 1.03868 10.94

---

11

9.09 .95856 9.09 .95856

10.59 1.02490 10.09 1.00389

$\bar{1}.93366$ $\bar{1}.95467$

62.66 1.79698 65.77 1.81799

$\bar{1}.86732$ $\bar{1}.90934$

2431 3.38583 2678 3.42785 ~~2678~~

$\bar{1}.73464$ $\bar{1}.81868$

8.685 0.93876 10.54 1.02280

12

8.333 .92080 8.333 .92080

9.833 .99269 9.333 .97002

$\bar{1}.92811$ $\bar{1}.95078$

61.86 1.79143 65.18 1.81410

$\bar{1}.85622$ $\bar{1}.90156$

2.370 3.37473 2631 3.42007 ~~263~~

$\bar{1}.71244$ $\bar{1}.80312$

8.252 0.91656 10.17 1.00724

194

13

7.692 .88604
9.192 .96341
$\bar{1}$.92263
61.08 1.[illegible]95

7.692 .88604
8.692 .93912
$\bar{1}$.94692
64.60 1.81824

$\bar{1}$.84526
2311 3.36377

$\bar{1}$.89384
2584 3.41235

$\bar{1}$.69052
7.846 0.89464

$\bar{1}$.78768
9.813 0.99180

14 7.14 .85370
8.64 .93651
$\bar{1}$.91719
60.33 1.78051

7.14 .85370
8.14 .91062
$\bar{1}$.94308
64.03 1.80640

$\bar{1}$.83438
2254 3.35289

$\bar{1}$.88616
2539 3.40467

$\bar{1}$.66876
7.462 0.87288

$\bar{1}$.77232
9.472 0.97644

195

15 6.667 .82392
8.167 .91206
$\bar{1}$.91186
59.59 1.77578

6.667 .82392
7.667 .88463
$\bar{1}$.93929
63.47 1.80261

$\bar{1}$.82372
2199 3.34223

$\bar{1}$.87858
2495 3.39707

$\bar{1}$.64744
7.105 0.85156

$\bar{1}$.75716
9.147 0.96128

16 6.25 .79588
7.75 .88930
$\bar{1}$.90658
58.87 1.76990

6.25 .79588
7.25 .86034
$\bar{1}$.93554
62.93 1.79886

$\bar{1}$.81316
2146 3.33167

$\bar{1}$.87108
2452 3.38959

$\bar{1}$.62632
6.768 0.83044

$\bar{1}$.74216
8.836 .94628

06

17) 5.882 .76953 5.882 .76953
7.382 .86817 6.882 .83771

$\bar{1}.90136$ $\bar{1}.93182$
58.17 1.76468 62.39 1.79514

$\bar{1}.80272$ $\bar{1}.86364$
2095 3.32123 2411 3.38215

$\bar{1}.60544$ $\bar{1}.72728$
6.450 0.80956 8.539 0.93140

18) 5.556 .74468 5.556 .74468
7.056 .84856 6.556 .81664

$\bar{1}.89612$ $\bar{1}.92804$
57.47 1.75944 61.85 1.79136

$\bar{1}.79224$ $\bar{1}.85608$
2045 3.31075 2369 3.37459

$\bar{1}.58448$ $\bar{1}.71216$
6.146 0.78860 8.247 0.91628

---

19) 5.263 .72123 5.263 .72123
6.763 .83014 6.263 .79678

$\bar{1}.89109$ $\bar{1}.92445$
56.81 1.75441 61.33 1.78777

$\bar{1}.78218$ $\bar{1}.84890$
1998 3.30669 2330 3.36741

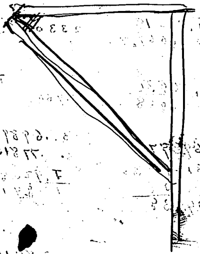
$\bar{1}.56436$ $\bar{1}.69780$
5.868 0.76848 7.960 0.90192

20) 5. .69897 5. .69897
6.5 .81291 6. .77815

$\bar{1}.88606$ $\bar{1}.92082$
56.15 1.74938 1.78414 60.83

$\bar{1}.77212$ $\bar{1}.84164$
1953 3.29063 3.36615 2294

$\bar{1}.54424$ $\bar{1}.68328$
5.602 0.74836 ~~7.716~~ 0.88740 7.716



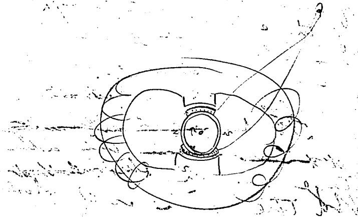
[illegible] The use of a high resistance for measuring strong currents.

A high resistance ~~at~~ differential galvanometer of Elliot Bros has been at my disposal during the past year. With this were resistance boxes containing 60,000 Ohms and a box which contained resistances varying from one hundredth of an Ohm to ~~500~~ five thousand which were used ~~as~~ to make a shunt around the gal[illegible]nometer. The size of the resistance 60,000 Ohms made it possible to measure electromotive force by placing various batteries of various strengths in the current and taking the deflection to represent the E.M.F. of the cell by neglecting its resistance. It also made the assumption true that if the ends of the circuit containing ~~the high~~ resistance galvanometer were ~~shunted~~ ~~with any part of another~~ placed at the extremities of a resistance where a strong current was flowing not enough

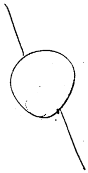
would escape to make any practical ~~st~~ difference in the flow. ~~Thin being the case it can be~~ Thus the galvanometer readings would denote the difference of potential between the ends of the circuit containing it and for all practical uses in measuring currents may be considered as an Electrometer.

It has ~~several advantage that is also~~ this advantage over a Electrometer ~~that~~ As the wire used ~~should~~ be [illegible]

[illegible]



[illegible]



·090
·868

[illegible] ·958 ) 3000.010 ( 3131
2874
1260
958
3020
2874
1470
958
512

[illegible] ) 958

English ·958

~~[illegible]~~
Bowdoin

3131 times as much Hg. in bulb as in tube

$\frac{1}{3131}$ in tube as in bulb

~~1(54)750 (5~~

175 ) 760 ( 4.34
700
600
525
75

3131
4.34
12524
9393
12524
13588.54

$\frac{1}{4.34}$

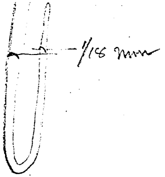
$\frac{1}{13.588}$ part of Atmosphere

$\frac{1}{1,000,000}$

13.588 ) 760.00 ( .03

760 ) 13.588 ( 18
760
5988

$\frac{1}{18}$ mm



1.000 000   6.

13588   4.13308

$$\frac{6.\phantom{00000}}{}\quad \begin{array}{r} 4.13308 \\ \hline 1.86692 \end{array}$$

73.6 M

74M

---

$$\frac{75}{175} = \frac{3}{7}$$

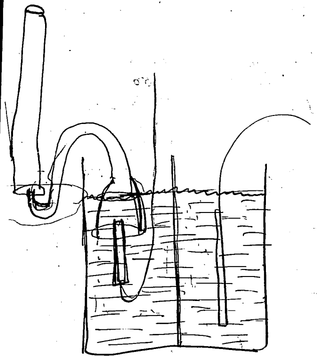
74

3

$$7\overline{)212}$$

30.3 m

---



~~Meter~~

lamp conductor $ 6.00
lamp .50
~~HP~~ 11.00
Dynamos 2.00

10 lamp per H. P.

1 H.P. costs ~~110~~ $110

two 19.50

$20.00 investment per lamp

used

200 cents a year

$\frac{2}{3.65} = \frac{1}{1.8}$ – 1.8) 1.00 (.55
190
100

.55 cts per day interest

Expenses per hour 1.5 H.P.
othe .5
2.

150 4 hours

11.00 11.00 7700 .8
.55
77000 7700 7700 11.00 1.35 per day
$ 11.00
11.00 11.00 .39 11.00
11.00 11.00 7700 770 c 4 ct. per hour
4 hours 150 Ohm lamp
15 per H.P.
4 hours hours
hours

Power will pay for expense

5 1/2 ct per hour

H.P $11.00

32 1/2 minutes

1 Weber Chlorine

180 cc.

32.5) 180.0 (55
1625
1770
1625
1450

5

5.5 CC. per minute
per Weber

.092 per second

---

25.5 minutes

1.2 Webers

180 CC

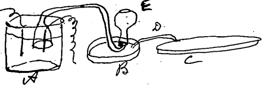
~~12) 2575~~

25.5
1.2
510
255
3060

30.60) 180.0 (59
1530
2700

5.9 CC. per minute

The Ch. was freed in from a carbon plate in an apparatus like this



A decomposition cell
B small pneumatic trough
C a pan of $H_2O$ connected with
B by siphon D so that as the
water ~~out~~ escaped from vessel E the level

in B would not change.

---

In the first determination there was considerable uncertainty in the deflection.

$$C' + C'' = C$$

$$\frac{1}{R'} + \frac{1}{R''} = \frac{1}{R}$$

$$\frac{R'' + R'}{R'R''} = \frac{1}{R}$$

$$R = \frac{R'R''}{R'+R''}$$

$$1/19 \quad \cancel{\frac{\frac{1}{10}\times\frac{1}{10}+\frac{1}{9}}{\frac{1}{10}+\frac{1}{9}}} = \cancel{\frac{\frac{1}{10}\times\frac{1}{9}}{\frac{19}{90}}} = \cancel{\frac{\frac{1}{90}}{\frac{19}{90}}} = \frac{1}{19}$$

1/19)1

27888    418

~~8.7311~~

15686    362

46665    34666

3018    2840

2676

Rework 31 page 208

10.1

101
201

2.0043
1.3032
.7011

5.02
.053
5.0253

15.02

~~70044~~
~~7041~~
.0003

1.7014
1.1764
.5250

15.02

3.35
.0370
3:387

525

5.02
.05
5.07

15.07

.7050
.1783
~~.8833~~
5267

3.36

3.36
.037
13397

253

1.5302
1.1266
.4034

W W W

1/10 10.30

~~[illegible]/108~~ ~~11/[illegible]~~ 103/104

1 103/104 .0128 .9916

.0170

.9958 99 .9832

99 114/115 .0569

.0607

2 .9962 98.2

.9958 .9840

.9920

3 126/127 .9965 .9680

.9885 97.4

4 1446/1456 .9970

.9855 96.7

5 1682/1689 .9974

.9829 96.1

201/202 6 .9829

.9978

.9807 95.7

.9983

250/251 7 .9790 95.3

333/334 8 .9987

.9777 95.

50/50 9 .9992

.9769 94.8

.9996

10 .9765 94.7

Book 3 page 260
& 192

10.1 X10
20.1

2.0043
1.3032
.7011

9542
43
.9499 89.1
.8998 79.4
.7996 63.0
1.2041
1.0637 10.1 Candles

9

5.02

~~50.3 X10~~
~~15.3~~

5.02
.052
5.072 X10
15.07

1.7052
~~1.1923~~
~~.5129~~

~~3.26~~

1.7052
1.1781
.5271

8

3.37

9583
41
.9542 90
.9084 81
.8168 65.6 2.0209 10.5 candles
~~9636~~
53
.9583 90.8
.9166 82.5
.8332 68.1
2.0373

10.9 Candles

~~8~~ 7 3.37
.037
3.407 X10
13.40

2.54

1.5324
1.1271
.4053

9680
44
.9636 9.2
.9272 84.6
.8544 71.5
2.0585 11.4

6

2.54
.029
2.569 X10
12.569

2.04

1.4097
1.0994
.3103

.9727
47
.9680 92.9
.9360 86.3
.8728 74.5
2.0769 11.9

5

2.04
.025
2.065 X10
12.06

1.71

1.3150
1.0814
.2336

.9776
~~.2336~~
[illegible]
.9727 93.9
.9454 88.2
.8908 77.8
2.0949 12.4

4

1.71
.022
1.732 X10
11.73

1.2385
1.0693
.1692

1.477

.9837
.1692
.8247
.9776 95
.9552 90.2
.9100 81.3
2.1141 13.

3

1.477
020
1.497 X10
17.497
1.30

1.1753
1.0603
.1150

97.5
1.3
comp 1.319

.9890
.1150
8797
.9837 96.3
.9677 92.8
.9348 86.1
2.1389 13.7

2

1.30
.019
1.319 X10
11.319
1.16

1.1203
1.0539
.0664
~~.0223~~
~~.9559~~ ~~90.3~~
~~.9118~~
~~.8236~~

98.5
1.16
Comp 1.178

.9937
.0664
.9289
.9890 97.5
.9780 95.0
.9560 90.4
2.1601 14.5

1

1.16
.018
1.178 X10
11178

1.053
1.068

1.0711
1.0488
.0223
.0286
.9937 98.5
.9874 97.1
.9748 94.4
2.1789 15.1

0

1.05
.018
1.068 X10
~~11.068~~
~~1.965~~

~~1.0286~~
~~1.0448~~
~~.4846~~

100 1/24 24

9832
2
1.9664
2
.9328
.2041
.1369

1.04 Ohms 6 feet 6 in

6 1/2 feet

1.04)650 (6.25 feet one Ohm
624
260
208
520

75.8

.24.5

.245 Ohms

18. 10hm

12)10
.245)18.9.33 (
1.2765
1.3892
1.8873
77.1 feet per Ohm

.0182 $\bar{2}.2601$

771 1.8871

.1472

1.4 feet 1ft 5 inches

.0185 $\bar{2}.2672$

1.8871

1.42 1ft 5½ inch .1543

.0192 $\bar{2}.2833$

1.8871

~~.1543~~

1.48 1ft 6 inches .1704

0204 $\bar{2}.3096$

1.8871

.1967

1.57 1ft 6½ inches

0222 $\bar{2}.3464$

.2335

1.71 1ft 8 inch

.0250 $\bar{2}.3979$

.2850

1.93 1ft 10 inch

.0294 $\bar{2}.4683$

.3552

2.26 2ft 3 inch

.0370 $\bar{2}.5682$

.4553

.0526 2.85 2ft 9 inch

$\bar{2}.7210$

.6081

101 4.06 4ft ½ in

7.7 7ft 8 inches

~~10 feet~~ 5/12 10

14 feet 4 inches
14 10 inches
15 4
16

---

16 6 inch 8/12 10

18 feet
26 feet

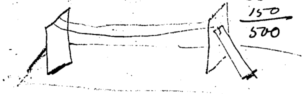
~~1 f~~

| Feet | Inches |
|---|---|
| 1 | 5 |
| 1 | 5 1/2 |
| 1 | 6 |
| 1 | 6 1/2 |
| 1 | 8 |
| 1 | 10 |
| 2 | 3 |
| 2 | 9 |
| 4 | 1/2 |
| 7 | 8 |

182

350
150
250
750

350
150
500



.0041
30
.1230

0131
30
.3930

.0173
60
1.0380

0215
60
1.2930

.0249
30
.7470

.0081
20
.1620

.0123
20
.2460

.0065
650

.163
20
.326

1/4 of system

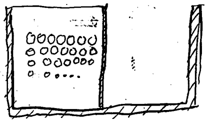
| | | | | | |
|---|---|---|---|---|---|
| A | 30 | houses | ~~250~~ | feet | 250 |
| B | 30 | houses | ~~750~~ | feet | 810 |
| C | 60 | houses | ~~950~~ | feet | 1070 |
| D | 60 | houses | ~~1150~~ | feet | 1330 |
| E | 30 | " | ~~1350~~ | " | 1590 |
| F | 20 | " | ~~500~~ | " | 500 |
| G | 20 | " | | " | 760 |
| H | 20 | " | | " | 1020 |
| J | 10 | " | | " | 400 |

1 ohm
290

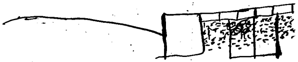
Contractors in the ~~streets~~

350 350 feet 350
350 feet 350 350 feet

350



350
350
350



2140
1200
940

27.6
60
1656.0

8580
1656
6824 lbs saved
20

7 blocks

2 Avenue
14 blocks

200
60
260
3
780
1270
910 feet

850
2
1600

910
850

910
850

500:500 :: 1 : 2 1

$$\begin{array}{r} 17\,)\,1143\,(67 \\ 102 \\ \hline 123 \\ 119 \\ \hline 4 \end{array}$$

$$\begin{array}{r} 1143 \\ 6 \\ \hline 6858 \\ 67 \\ \hline 6925 \\ 342 \\ \hline 2\,)\,7267 \\ \hline 3633 - 1 \end{array}$$

$10\,)\,366$ 6 $\frac{6}{10}$ $\frac{3}{5}$

36.6

$$\begin{array}{r} 838 \\ 806 \\ \hline 1644 \end{array}$$

$$\begin{array}{r} 832 \\ 808\frac{1}{2} \\ \hline 1640\frac{1}{2} \end{array}$$

$$\begin{array}{r} 835 \\ 808 \\ \hline 1143 \end{array}$$

$$\begin{array}{r} 837\frac{1}{2} \\ 804 \\ \hline 1641\frac{1}{2} \end{array}$$

$$\begin{array}{r} 838 \\ 808 \\ \hline 1646 \end{array}$$

$\frac{3}{2}$

$\frac{3}{7}$ $\frac{6}{2}$

$\frac{13}{24}$

$\frac{3}{2}$

$\frac{3}{2}$

$\frac{3}{2}$ $\frac{3}{4}$